Optimal recycling of reclaimed asphalt pavement

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ORRAP

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Recyclage optimal des agrégats de béton bitumineux dans les chaussées à faible trafic

Optimales Recycling von Ausbauasphalt auf verkehrsschwachen Straßen

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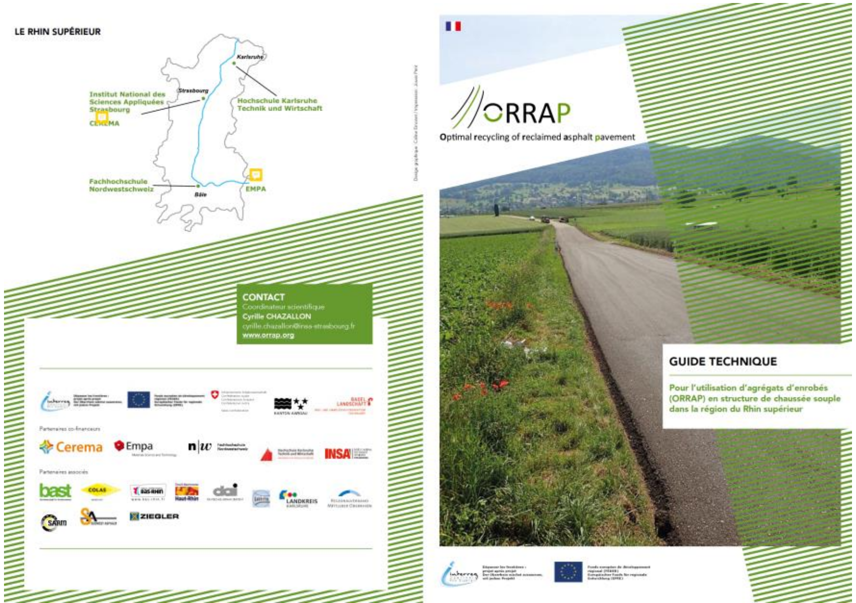
Presentation of the Guide

Arnaud Feeser, Cerema



Cerema

General information

- Guide drawn up :
  - following the various works carried out
  - after completion of the test sections
  - recently finalised in order to benefit from the most recent results
- Guide available in german, french and english
- Guide divided into 6 main parts

Table of contents of the guide

Part I : Context

- Presentation of the general problematic
  - Need to recycle
  - Budgetary constraint
  - Environmental and health constraints

- Presentation of the ORRAP approach
  - 100% recycling
  - at ambient temperature
  - without the addition of binders or additives

Part II : Field of application

- Traffic recommendation for use of the method

- Reminder of Asbestos / PAH / Hydrocarbons content requirements

<table>
<tr><th></th><th colspan="4">ORRAP possible</th><th colspan="5">Non recommandé pour ORRAP</th></tr>
<tr><td>France : traffic class</td><td>T5 (≤ 25)</td><td colspan="2">T4 (25 - 50)</td><td>T3 (50 - 150)</td><td>T2 (150 - 300)</td><td colspan="2">T1 (300 - 750)</td><td colspan="2">T0 (750 - 2000)</td></tr>
<tr><td>Germany : traffic load Bk</td><td colspan="2">Bk 0.3</td><td colspan="2">Bk 1.0</td><td>Bk 1.8</td><td>Bk 3.2</td><td>Bk 10</td><td>Bk 32</td><td>Bk 100</td></tr>
<tr><td>Switzerland : traffic class</td><td>T1 (≤ 30)</td><td colspan="2">T2 (30 - 100)</td><td>T3 (100 - 300)</td><td>T4 (300 - 1000)</td><td colspan="2">T5 (1000- 3000)</td><td colspan="2">T6 (3000 - 10000)</td></tr>
</table>

<table>
<tr><th></th><th>Germany</th><th>Switzerland</th><th>France</th></tr>
<tr><td>Asbestos</td><td colspan="3">NO</td></tr>
<tr><td>PAHs</td><td>0 – 25 mg/kg</td><td colspan="2">0 – 500 mg/kg</td></tr>
<tr><td>Hydrocarbons</td><td colspan="2">-</td><td>0 – 300 mg/kg</td></tr>
<tr><td>Lower quality asphalt aggregates</td><td colspan="2">(YES)</td><td>(YES)</td></tr>
</table>

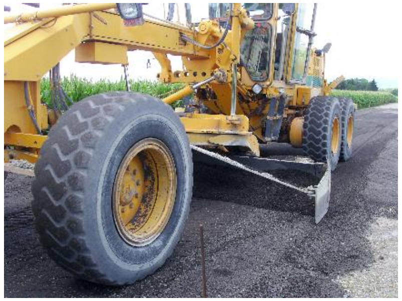
Part III : Issues

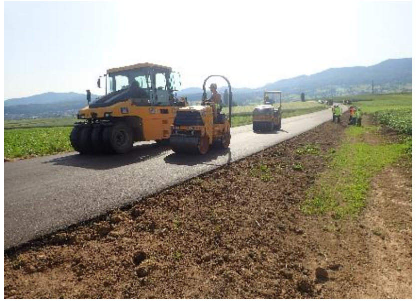
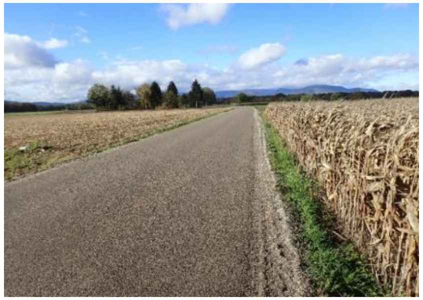
- Assessment of sustainability and health aspects
  - Purpose of the sustainability assessment
  - Environmental impact
  - Economic approach
  - Impact on road users
  - Human toxicity and Ecotoxicity

	Frais de matériel, de transport, de chantier (économie)	Demande d'énergie pour la production de matériaux, les chantiers de construction, les transports (économie et environnement)	Consommation de matières (environnement)	Temps de trafic supplémentaire (utilisateur du trafic)	Demande d'énergie pour le trafic supplémentaire (environnement)	Toxicité humaine et écotoxicité (HAP)
Épaisseur de la couche	X	X	X			X
Hypothèse de durée de vie	X	X	X	X	X	X
Nécessité d'une couche de surface	X	X	X	X	X	X
Distance entre la production de matériaux et l'usine de mélange /le chantier de construction	X	X				
Distance supplémentaire de déviation				X	X	
Volume du trafic de déviation				X	X	
Limites de HAP dans les matériaux et manipulations requises						X

Part IV : Production, development, implementation

- Assessment of sustainability and health aspects
  - Origin and deposits
  - Production process (milling, crushing/screening, storage)
  - Substrate preparation
  - Application
  - Material characteristics and Product Data Sheets (PDS)



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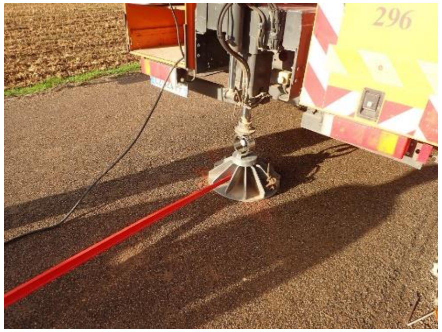
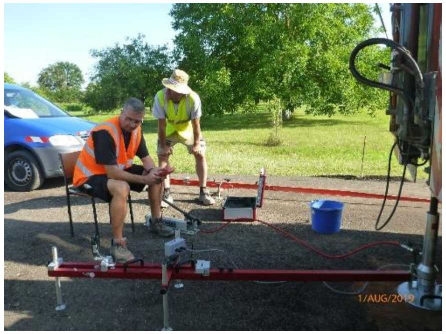
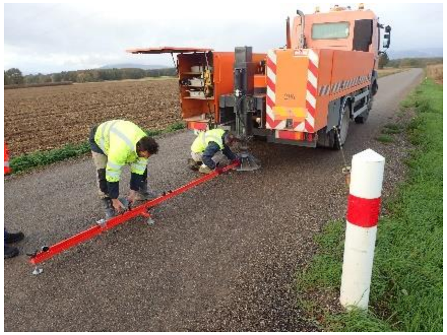
Part V : Controls

- Controls on substrate preparation
- Controls on site (water content, voids & thickness)
- Laboratory Controls (comparison with PDS)
- Controls after application, between 3 and 6 months







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Part VI : Summary

- Main recommendations (and points of vigilance)
- Comparison with other technics

	ORRAP compared to UGM	ORRAP compared to hot mix
Mechanical performance	= / + (early age) / (long term)	-
Ease of fabrication	= / + (UGM of quarry) / (UGM plant)	+ (no plant)
Ease of storage	- (creation of chunks)	+ (cold material)
Ease of implementation	- (difficulties of compaction)	- (difficulties of compaction)
Ease of characterisation	- (binder content)	+ (less test requirements)
Recyclability	=	- (potential presence of PAH)
Behaviour at an early age	- / = (rutting risk) /	- (rutting risk)
Long-term behaviour	+	- (stiffness)
Key : + : better	= : equal	- : worse

Asphalt surface course necessary?	no				yes			
Reduced lifetime of the ORRAP course compared to a conventional asphalt base course?	no		yes		no		yes	
ORRAP course can be prepared and reused on construction site?	yes	no	yes	no	yes	no	yes	no
Assessment of primary energy demand *1)	+++	+++	++	++	+	+	0	0
Assessment of primary construction materials	+++	+++	++	++	0	0	-	-
Assessment of construction costs	+++	+++	++	+	+	0	-	---
Assessment of time required by users due to shorter blocking times of the route	+++	+++	+	+	0	0	---	---

1) Primary energy demand directly attributable to the construction measure, without taking into account the additional fuel consumption due to diversion traffic resulting from the construction measures

Figure 10: Sustainability comparison of ORRAP method with a use of pavement with asphalt concrete hot mix

Asphalt surface course necessary?	no		yes	
ORRAP course can be prepared and reused on construction site?	no	yes	no	yes
Assessment of primary energy demand *1)	+	++	+	++
Assessment of primary construction materials	+++	+++	+++	+++
Assessment of construction costs	+	++	+	++
Assessment of time required by users due to shorter blocking times of the route	0	0	0	0

1) Primary energy demand directly attributable to the construction measure, without taking into account the additional fuel consumption due to diversion traffic resulting from the construction measures

Figure 9: Sustainability comparison of ORRAP method with an UGM with natural aggregates

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Thank you for your attention

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Final Guide

3.2: Assessment of sustainability and health aspects

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Possible boundary conditions and their effects on the sustainability assessment

	Material, transport, construction site costs (econ.)	Energy demand for material production, construction site, transports (econ. and environm.)	Material consumption (environm.)	Time for additional traffic (traffic user)	Energy demand for additional traffic (environm.)	Human toxicity and ecotoxicity (PAH)
Layer thickness	X	X	X			X
Lifetime assumption	X	X	X	X	X	X
Need of an additional asphalt surface course	X	X	X	X	X	X
Distance between material production and mixing plant/construction site	X	X				
Additional distance of diversion				X	X	
Volume of diversionary traffic				X	X	
PAH limits in material and required handling						X

Environmental impact

Primary energy demand and global warming potential (GWP)

The ORRAP method can lead to **significant savings** of the primary energy demand and GWP:

- They can be significantly reduced by the ORRAP method compared to hot mix structure (pavement with asphalt concrete hot mix), **especially if no asphalt surface course is provided**;
- They can be somewhat reduced by the ORRAP method compared to the UGM layer;
- They can be significantly reduced if the **existing ORRAP layer is removed, reprocessed on site and reinstalled** in comparison of moving it to a plant.

The primary energy demand and GWP for the diversion traffic are significant, but generally much lower than for the construction measure. Primary energy demand and GWP are higher if long diversion routes and/or heavy diversion traffic are considered.

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Environmental impact

Use of natural resources

The ORRAP method can lower primary construction material demand:

- It is **slightly lower** with ORRAP method compared to the hot mix structure, **if no asphalt surface course is provided**. If an asphalt surface course is necessary, the primary construction material demand is nearly the same as a hot mix structure;
- It is **significantly lower with ORRAP method compared to the construction method with an UGM layer with primary natural aggregates**.

The ORRAP method **increases the use of reclaimed asphalt** compared to UGM layer, which can reduce stockpiles. The use of RAP is also higher with the ORRAP method than with a hot mix structure. However, only when the ORRAP layer is produced for the first time, as the necessary material can be removed when the ORRAP layer is renewed.

Environmental impact

Environmental scarcity points

The environmental indicators were also aggregated with the environmental scarcity method, which is based on Swiss environmental policy. The results indicate a **slightly better performance (12%) for ORRAP** (see Annex 2).

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Economic approach

The ORRAP method can lead to **significant construction cost savings** under the following conditions (landfill costs are not considered):

- Construction costs can be reduced by the ORRAP method compared to a hot mix structure, **if no asphalt surface course is provided**;
- Compared to the construction method with an **UGM course, the costs are approximately the same**;
- The costs can be lowered if material transports can be reduced. This is possible if the existing ORRAP course is removed, reprocessed **on site** and reinstalled.

Impact on road users

The ORRAP method and a hot mix structure require **the same time for construction** and thus have the same impact on traffic for a single construction. However, if the ORRAP course has a **shorter lifetime**, the additional renewal measures will lead to **more time losses for road users**. The longer the diversion route and/or the greater the volume of traffic to be diverted, the greater the time loss **and other impacts** on road users.

Human toxicity and Ecotoxicity

The human toxicity and ecotoxicity (environment) from PAH were calculated with the USEtox model. According to the method, exposure for fume give the highest and exposure for dust the second highest toxicity score. However, this effect might be because the data used is not representative enough. PAH exposure by fume was assumed proportional to the amount of hot processed RAP, which is part of the reference hot mix base layer but not the ORRAP layer. PAH exposure through dust was further assumed proportional to the total amount of processed RAP, hot and cold. This amount is higher for the ORRAP method. Consequently, the **PAH-exposure through fume is lower with the ORRAP method but the PAH-exposure by dust is higher.**